



## THE INVASIVE BUDDLEJA DAVIDII (BUTTERFLY BUSH)

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### Abstract:

*Buddleja davidii* Franchet (Synonym. *Buddleia davidii*; common name butterfly bush) is a perennial, semi-deciduous, multi-stemmed shrub that is resident in gardens and disturbed areas. Since its introduction to the United Kingdom from China in the late 1800s, *B. davidii* has become an important component in horticulture and human culture. Despite its popularity as a landscape plant, *B. davidii* is considered problematic because of its ability to naturalize outside of gardens and rapidly invade and dominate disturbed natural areas across a wide range of physical conditions. The primary goal of this paper is to synthesize what is known about *B. davidii* in order to understand the impacts caused by the continued presence of *B. davidii* in gardens and natural landscapes. We also address management of *B. davidii* and discuss the repercussions of management strategies and policies currently implemented to protect or remove *B. davidii* from natural ecosystems.

Zusammenfassung *Buddleja davidii* Franchet (Synonym *Buddleia davidii*, umgangssprachlich "Schmetterlingsflieder") ist ein ausdauernder, halb-immergrüner, mehrstämmiger Busch welcher in Gärten und auf Umbruchflächen gedeiht. Seit seiner Einführung in die UK aus China im späten 19. Jahrhundert hat *B. davidii* in Pflanzenzucht und Kultivierung stark an Bedeutung gewonnen. Unabhangig von seiner Beliebtheit in der Landschaftsgestaltung stellt *B. davidii* wegen seiner Fähigkeit, sich über Gartengrenzen hinaus unter einer Vielzahl von Wachstumsbedingungen in gestörten Naturgebieten schnell auszubreiten und dort die einheimische Flora zu dominieren, ein großes Problem dar. Das Ziel der vorliegenden Rezension ist es eine Synopsis zu erstellen, welche die Auswirkungen und Gefahren der konstanten Präsenz von *B. davidii* in Gärten und der Naturlandschaft verdeutlicht. Management Optionen und -Fehlschläge sowie aktuelle Regulationen zu dem Zwecke *B. davidii* aus natürlichen Ökosystemen zu entfernen oder sein Vordringen zu verhindern, werden ebenfalls diskutiert.

Keywords: *Buddlejadavidii*. *Buddlejaceae*. *ButterflyBush*. Invasive Species

### Introduction:

*Buddleja davidii* Franchet is a perennial, semi-deciduous shrub or small multi-stemmed tree that readily establishes on disturbed sites in regions with temperate, subtropical, and tropical climates. Native to central and western China, *B. davidii* has been introduced as an ornamental to the Americas, Australia, Europe, and New Zealand because of its fragrant and colorful flowers (Synonym. *Buddleia davidii*, *Buddlea davidii*; *Buddleia variabilis* Hemsl., *Buddleia magnifica* Hort, *Buddleia nanoensis* Hort; Bailey & Bailey, 1976; Bricknell & Zuk, 1997; Family *Buddlejaceae*; Common names: butterfly bush, orange-eyed butterfly bush, summer lilac).

In the 100 years since *B. davidii*'s introduction, the tree has spread from gardens to disturbed and natural areas including floodplains, railroad and road edges, forest burns, and clear-cuts. Horticulturalists, landscapers, gardeners, butterfly enthusiasts, bird watchers, and the general public welcome and celebrate *B. davidii*'s colorful and fragrant place in urbanized landscapes (Coats, 1992; Dirr, 1997; Dole, 1997; Klingaman, 2002; Wilson et al., 2004a; Forrest, 2006; Stuart, 2006; KCGG, 2007; Savonen, 2009). However, many others consider *B. davidii* invasive and problem-atic. There is concern that it has potential negative and irreversible impacts on agricultural and wild lands it invades (Richardson et al., 1996; Reichard & Hamilton, 1997; Anisko & Im, 2001; Reinhardt et al., 2003; Wilson et al., 2004b; PIER, 2005; WSNWCB, 2006). The desire to protect the continued presence of *B. davidii* in gardens is matched by the concern by land managers to control *B. davidii*. It is clear that *B. davidii* is an important component of both horticulture and society (Stuart, 2006). Considering the level of interest in *B. davidii* by both the public and land managers, a thorough understanding of the ecological impacts of *B. davidii* naturalization over the long-term is required.

Despite research on the distribution, ecology, physiology, and management of *B. davidii* gaps exist in our knowledge about native and non-indigenous *B. davidii*. The primary goal of this paper is to synthesize what is known about *B. davidii* so that ecologists, horticulturalists, and others can fully appreciate the impacts of the continued presence of *B. davidii* in gardens and natural landscapes, and understand the repercussions of management efforts. This review of the literature concerning *B. davidii* is divided into seven sections: history, taxonomy, distribution, biology, ecology, human ecology, and management.

#### Literature Review:

##### History of *B. davidii*

*B. davidii* was introduced to Europe in 1869 by French missionary, Father David from the Moupine Province, East Tibet, and, again, by Dr. Augustine Henry (Nelson, 1980) in 1887 from the I-ch'ang Province of China. The genus *Buddleja* was named by von Linné (1737) to honor the English amateur botanist, Reverend Adam Buddle (Chittenden, 1951; Buddle, 2008; Noltie, 2008). The species was named after Father David who collected and returned specimens of the Chinese flora and fauna to Adrien René Franchet at the Paris Musée National d'Histoire Naturelle (Bean, 1970).

David sent Franchet specimens of *B. davidii* in 1869 (Franchet, 1884, 1888). Specimens of the same species from I-ch'ang Province were collected by Henry and named by William Botting Hemsley in 1887 (Anon., 1925). Unaware of Franchet's description, Hemsley called the plant *B. variabilis* Hemsl. (Hemsley, 1889). The name was eventually reversed 25 years later, due to the discovery of Franchet's original description. However, *B. variabilis* is still listed as a synonym of *B. davidii*.

*B. davidii* seeds were first introduced to Europe from Russia by traders (Bean, 1970). These seeds were reported to produce, from a horticultural perspective, an inferior form (Bean, 1970; Coats, 1992). A second form was introduced to Louis DeVilmorin of France from Tatsienlu, China, in 1893 by Jean André Soulié (Herberman, 1919). This form produced what was considered a superior plant (i.e., erect habit, flowers in denser and longer panicles; Cox, 1986). Once grown, the plant resembled *B. davidii* var. *veitchiana* that was later introduced to the United Kingdom (UK) by Ernest Wilson (National Council for the Conservation of Plants and Gardens, 2007). DeVilmorin sent seed from the Tatsienlu specimens to the Kew Gardens in 1896 (Coats, 1992).

Further collections of *B. davidii* seeds were sent from Mt. O'mei Shan, China in 1896 by another French missionary (and botanist) Father Paul Guillaume Farges (ThePlantExplorers.com, 2007) and in the following year by Henry from I-ch'ang. Wilson collected *B. davidii* for its numerous and attractive seed capsules (not flowers) in the Hupeh and Szechwan regions of China during the years 1907–1910 from which the common garden-variety *B. davidii* descended (Rehder, 1927; Bean, 1970). However, some of the naturalized plants in the UK may have originated from the earlier seed collections or from hybrids with the original stocks (Miller, 1984).

Taxonomy of *B. davidii*

The Family Buddlejaceae

The classification of the genus *Buddleja* has been in flux for some time (Oxelman et al., 1999; Norman, 2000; Houghton et al., 2003). *Buddleja* was originally ascribed to the family Scrophulariaceae by de Jussieu (1789), Bartling (1830) and Lindley (1846), yet it was later reclassified in the Loganiaceae by Bentham (1857) and Bentham and Hooker (1876). Wagenitz (1959), Leenhouts (1963), Leeuwenberg (1979) and Leeuwenberg and Leenhouts (1980) continued to treat *Buddleja* and its allies as a tribe of Loganiaceae even though Wilhem (1910) gave Buddlejaceae family rank next to the Loganiaceae (Norman, 2000). Melchoir (1964) recognized the family Buddlejaceae which he placed in the Tubiflorae near the Scrophulariaceae. Cronquist (1981), Takhtajan (1980, 1986), Dahlgren (1983, 1989a, b), and Thorne (1992) concur with the placement yet when they elaborate the contents of the family, they do not completely agree (Norman, 2000; Houghton et al., 2003). Oxelman et al. (1999), Olmstead et al., (2001), Oxelman et al. (2005), and Tank et al. (2006) present strong evidence of the scrophulariaceous affinity of the Buddlejaceae based on molecular phylogenetic studies.

The confusion does have merit. Embryological studies support assignment to Scrophulariaceae (Norman, 2000). However, Scrophulariaceae does not have stipules as does the genus *Buddleja*. Furthermore, Houghton et al. (2003) excluded the genus *Buddleja* from the Loganiaceae based on chemosystematic aspects of terpenoids (iridoids and aucubins) present in the plants and suggested that the genus should be included in a new taxon including the Scrophulariaceae and Lamiaceae. In spite of supporting and opposing evidence for place in various families the convention at present is to place the genus *Buddleja* and other related genera in the family Buddlejaceae based on morphology, embryology, and chemistry (Oxelman et al., 1999; Norman, 2000; Olmstead et al., 2001; Oxelman et al., 2005; Tank et al., 2006).

The Buddlejaceae consists of angiosperms that are trees, shrubs or lianas that are self-supporting or climbing. The eight genera in Buddlejaceae occur in warm, tropical, and subtropical climates (Norman, 2000): *Androya* (one species, Madagascar); *Buddleja*, (ca. 100 species and cultivars, native to the Americas, Africa and Asia); *Chilianthus* (three species, South Africa); *Emorya* (one species, Texas and Mexico); *Gomphostigma* (two species, South Africa); *Nuxia* (fifteen species, southern Arabia and tropical Africa); *Peltanthera* (one species, tropical America); and *Polypremum* (one species, warm regions in America). The African genera *Adenopplusia* and *Nicodemia* were recently reclassified in *Buddleja* (Adkins, 2004). There are no native plants of the Buddlejaceae in Australia, New Zealand, or Europe (Stuart, 2006).



Chromosomal analyses indicate that the basic chromosome numbers of this family are seven and 19 (Moore, 1947; Norman, 2000). Ploidy levels recorded are two, four, six, 12, 16, and 38. About 48% of species in the genus *Buddleja* have been described based on differences in cytology. Polyploidy appears most frequently in Asian species (Moore, 1947, 1960). Chen et al. (Chen & Sun, 2006; Chen et al., 2007) found the basic chromosome number of 27 populations of 14 *Buddleja* species was  $x=19$  with the presence of several ploidy levels. Specifically, the species *B. davidii* has a tetraploid number of  $2n=76$  (Moore, 1960; Chen et al., 2007)

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